THE VARIETIES OF *MONECPHORA BICINCTA* FROM THE POINT OF VIEW OF A CYTOLOGIST.

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A curious case of distribution in *Monecphora bicincta* and its variety *ignipecta* was called to my attention by Mr. A. P. Morse in the summer of 1921. Since then I have been studying the chromosomes of these forms to see whether a study of the internal cell phenomena would throw any light on their relationship.

In Psyche for February 1921 (vol. 28), Mr. Morse describes the case. The normal range of *Monecphora bicincta* var. *bicincta*, the form with red bands on its wings, is from southern New Jersey south, while the normal range of *Monecphora bicincta* var. *ignipecta*, the common black form, is from southern New Jersey north. Mr. Morse found a number of the variety *bicincta* near Norridgewock, Maine, while the variety *ignipecta* was taken in all other localities around. It is possible that that particular spot is subject to some peculiar environmental conditions which may have caused the banded form to appear there, but it does not seem likely that this aberrant colony could be due to environmental causes, when its environment, at least as far as general climatic conditions are involved, was apparently more like that of the nearby black colonies than of the other banded colonies in the south. What is the genetic status of these two forms? They apparently breed true within their range of distribution, since such aberrant groups as described by Mr. Morse are not frequent. They must then be genetically stable and according to present-day genetical theories there should be some physical basis for their phenotypic differences. Is the change from one to the other great enough to involve a visible cytological differentiation or is it a mutation in one gene of one chromosome as in the races of Drosophila and therefore not visible by present cytological methods?

The *Monecphora bicincta* var. *bicincta* material was very kindly sent to me at Woods Hole, Mass., in July, 1921, by Mr. Z. P. Metcalf and Mr. C. O. Eddy of the North Carolina Agricultural Experiment Station. The *M. bicincta* var. *ignipecta* material was collected at Wellesley, Mass., partly by Mr. Morse and partly by myself. I could not find Monecphora at Woods Hole, so trusted to obtaining it in September at Wellesley, as it was reported to be a late summer form. But the only specimens found as late as September 15 were females and they had laid their eggs and were much shrivelled in appearance. The material finally studied was collected in July, 1922 at Wellesley. A careful watch was kept from July 1 on for the first forms to appear. The first individual was taken on July 14. By July 21 the species was abundant. They appeared just as their food plant, the bunch-grass, was attaining its full growth. In looking over a field of the grass, one could pick out the Monecphora as conspicuous black specks clinging to the grass at various distances from the ground. I did not find any nymphs in their frothy masses of spittle on these plants although I carefully examined the young tufts of grass for some time before the adults appeared. In the *Monecphora bicincta* var. *bicincta* material sent me from North Carolina, the nymphs were on the roots of the food plants. These nymphs were not reared to assure their identity, but they were surrounded by a typical mass of white exudate and those old enough to contain mature sperm cells showed the same cytological conditions as the adults. Probably an examination of the roots of the young bunch-grass around Wellesley in early July, would show the habits of *Monecphora bicincta* var. *ignipecta* to be similar.

The cytological study of the chromosomes of these two varieties reveals them to be identical. This was tested by camera lucida drawings placed side by side. The spermatogonial number is 19, the primary spermatocyte 10, and the secondary spermatocyte 9 and 10. They are like other species of Cercopidæ studied (Boring '13 and Boring & Fogler '15) in having an X chromosome which divides in the second spermatocyte division. The chromosomes have the same absolute size in

the two varieties and show the same relative size differences within the group, 2 largest, 5 medium and 3 smaller (including X). These size differences are not clean-cut enough to be always certain but they are usually discernible in the primary spermatocytes.

Applying these facts to taxonomy, we can say that the cytology of *Monecphora bicincta* var. *bicincta* and var. *ignipecta* corroborates their close relationship. In some insects, as shown by the researches of McClung, Robertson and others on the grasshoppers the chromosome number is not a function of the species or genus but of the family. All species of the Acrididæ have 23 chromosomes and all species of the Tettigidæ have 27. A few apparent exceptions have proved to be due to fusion or breaking of certain chromosomes. The generic and specific differences are expressed in differences in chromosome size and arrangement within the given number. The degree of chromosome similarity has been found to correspond directly to the nearness of taxonomic relationship. But so far among the Cercopidæ studied each species has its own specific chromosome number so that the identity of number in the two varieties of *Monecphora bicincta* would substantiate their classification as varieties of the same species instead of as separate species. *Philœnus lineatus* has 15 as reduced number of chromosomes, while *Philœnus leucophthalmus* (*spumarius*) has 12; *Aphrophora parallela* has 15 while *Aphrophora quadrinotata* has 14 and *Aphrophora spumaria* (European form) has 12; *Lepyronia quadrangularis* has 11; *Clastoptera obtusa* has 8, while *Clastoptera proteus* has 7; but *Monecphora bicincta* has 10 and *Monecphora ignipecta* also has 10. The change from one to the other is not great enough to involve a visible change in chromosomes.

In two other species of Cercopidæ the cytological study of varietal forms has been recorded; *Philœnus leucophthalmus* (*spumarius*) collected from goldenrod and wild sunflower at Woods Hole and the European form, *Aphrophora spumaria*, collected from grass sweepings in a meadow at Eisenach (Boring, Biol. Bull. vol. 24.). In neither case were the varieties accurately identified and named, but a wide range of color and distinctness

of marking was observed and the testes preserved from individuals representing these differences. These specimens of Philænus were sent to Mr. Van Duzee at the time, 1912, and identified by him as all belonging to the species *Philœnus leucophthalmus* (*spumarius*). From a study of Mr. Van Duzee's Catalogue of the Hemiptera, 1917, I find many varieties of *P. leucophthalmus* recorded. The names of some of these are clearly descriptive of the somatic characters which were conspicuous in the Woods Hole material which I studied cytologically. The chromosome group in all these varietal forms was identical, the same situation as in the two varieties of *Monecphora bicincta*. There is therefore cytological evidence for the present systematic classification of the varieties of *Philœnus leucophthalmus* and of *Monecphora bicincta* as varieties instead of as separate species. In the Cercopidæ specific differences seem to be correlated with difference in number of chromosomes while varietal differences do not seem to be expressed in visible differences of any sort in the chrosomomes.

Those few specimens of the southern banded form of *Monecphora bicincta* at Norridgewock, Maine, raise other interesting questions, especially as to which was the original form. Evidently the banded form was the first one described. If it is the older, has the black form arisen from it as a result of suffusion? If so, what caused the return to the banded condition in those few specimens at Norridgewock? Can this be explained as a genetic reversion due to the chance recombination of genes? On the other hand, the black form may be the original which occasionally throws off banded mutants, those once thrown off in the south having firmly established themselves, those in Norridgewock being recent mutants. These questions are of course not to be answered by cytological methods. Experimental breeding would answer some. The cytologist must content himself with establishing these two varieties of *Monecphora bicincta* as belonging within one species.